

WHAT IS CLAIMED IS:

1. A method of measuring the dose of incident radiation by detecting stimulated fluorescence and prompt fluorescence at specified time intervals using a fluorescence detecting mechanism on the basis of two actions of a stimuable phosphor as a radiation detecting medium, one being the ability to accumulate an incident radiation and output the quantity of accumulated radiation as stimulated fluorescence and the other being the ability to emit prompt fluorescence upon excitation by an incident radiation.
2. The method according to claim 1, wherein if the fluorescence detecting mechanism is saturated to failure by the incidence of an intense radiation within a short period of time during detection of stimulated fluorescence and prompt fluorescence with the fluorescence detecting mechanism at specified time intervals, stimulated fluorescence is read after the recovery of the fluorescence detecting mechanism so as to measure the incident dose of intense radiation.
3. In an apparatus for measuring the dose of incident radiation by detecting stimulated fluorescence and prompt fluorescence at specified time intervals using a fluorescence detecting mechanism on the basis of two actions of a stimuable phosphor as a radiation detecting medium, one being the ability to accumulate an incident radiation and output the quantity of accumulated radiation as stimulated fluorescence and the other being the ability

to emit prompt fluorescence upon excitation by an incident radiation, wherein if the fluorescence detecting mechanism is saturated to failure by the incidence of an intense radiation within a short period of time during detection of stimulated fluorescence and prompt fluorescence, stimulated fluorescence is read after the recovery of the fluorescence detecting mechanism so as to measure the incident dose of intense radiation, the improvement wherein the fluorescence detecting mechanism is monitored for saturation on a time-division multiplexing basis and the dose of radiation accumulated in the stimuable phosphor is measured with the quantity of exciting light on the stimuable phosphor being altered in such a way as to ensure that the fluorescence detecting mechanism is not saturated to failure when reading the rapid intense dose of incident radiation after recovery from the saturated state.

4. In an apparatus for measuring the dose of incident radiation by detecting stimulated fluorescence and prompt fluorescence at specified time intervals using a fluorescence detecting mechanism on the basis of two actions of a stimuable phosphor as a radiation detecting medium, one being the ability to accumulate an incident radiation and output the quantity of accumulated radiation as stimulated fluorescence and the other being the ability to emit prompt fluorescence upon excitation by an incident radiation, wherein if the fluorescence detecting mechanism is saturated to failure by the incidence of an intense radiation within a short period of time during detection of

stimulated fluorescence and prompt fluorescence, stimulated fluorescence is read after the recovery of the fluorescence detecting mechanism so as to measure the incident dose of intense radiation, the improvement wherein the fluorescence detecting mechanism is monitored for saturation on a time-division multiplexing basis and the dose of radiation accumulated in the stimuable phosphor is measured with the sensitivity for fluorescence detection by the fluorescence detecting mechanism being altered in such a way as to ensure that the fluorescence detecting mechanism is not saturated to failure when reading the rapid intense dose of incident radiation after recovery from the saturated state.

5. The apparatus according to the combination of claims 3 and 4, wherein the fluorescence detecting mechanism is monitored for saturation on a time-division multiplexing basis and the dose of radiation accumulated in the stimuable phosphor is measured with both the quantity of exiting light on the stimuable phosphor and the sensitivity for fluorescence detection by the fluorescence detecting mechanism being altered in such a way as to ensure that the fluorescence detecting mechanism is not saturated to failure when reading the rapid intense dose of incident radiation after recovery from the saturated state.

6. In an apparatus for measuring the dose of incident radiation by detecting stimulated fluorescence and prompt fluorescence at specified time intervals using a fluorescence detecting mechanism on the basis of two actions of a stimuable phosphor as a radiation detecting

medium, one being the ability to accumulate an incident radiation and output the quantity of accumulated radiation as stimulated fluorescence and the other being the ability to emit prompt fluorescence upon excitation by an incident radiation, wherein the fluorescence detecting mechanism is monitored for saturation on a time-division multiplexing basis and if it is saturated to failure by the incidence of an intense radiation within a short period of time during detection of stimulated fluorescence and prompt fluorescence, stimulated fluorescence is read after the recovery of the fluorescence detecting mechanism so as to measure the incident dose of intense radiation, the improvement wherein the contribution from the measurement of prompt fluorescence due to incidental illumination of the stimuable phosphor with radiation is corrected on the basis of the dose of radiation measured at specified time intervals by counting the photons in prompt fluorescence using the fluorescence detecting mechanism.

7. A method for measuring the dose of radiation accumulated in a stimuable phosphor as a radiation detecting medium having a fluorescence lifetime of no longer than 2  $\mu$ s, comprising the steps of illuminating the stimuable phosphor with pulsed exciting light having an irradiation time not longer than the lifetime of stimulated fluorescence from the stimuable phosphor, detecting the emitted fluorescence with a photodetector, amplifying the detected signal with a charge-sensitive preamplifier, feeding the amplified output signal into a pulse shaping

amplifier where it is subjected to both waveform shaping with a time constant longer than the lifetime of stimulated fluorescence from the stimuable phosphor and amplification, and feeding the shaped and amplified signal into an analog/digital converter to determine the pulse height.

8. The method according to claim 7, wherein a gated photomultiplier tube is used as the photodetector and synchronously with the illumination of the stimuable phosphor with pulsed exciting light having an irradiation time not longer than the lifetime of stimulated fluorescence from the stimuable phosphor, the gate of the photomultiplier tube is controlled such that it remains off as long as the illumination continues but turns on after the illumination ends, and the emission of stimulated fluorescence from the excited stimuable phosphor is detected.

9. A method for measuring the dose of radiation accumulated in a stimuable phosphor as a radiation detecting medium having a fluorescence lifetime of no longer than 2  $\mu$ s, comprising the steps of illuminating the stimuable phosphor with pulsed exciting light having an irradiation time not longer twice the lifetime of stimulated fluorescence from the stimuable phosphor, detecting the emitted fluorescence with a photodetector, amplifying the detected signal with a signal amplifier, feeding the amplified output signal into a pulse height discriminator, picking up the signal for stimulated

fluorescence as a pulse signal, performing coincident counting on the pulse signal and a read signal constructed using a signal indicating the time duration of illumination with the pulsed exciting light, whereby the stimulated fluorescence signal is picked up on the basis of it being output in accordance with the lifetime of fluorescence upon illumination with the pulsed exciting light, and counting the number of stimulated fluorescence signals with a counter circuit.

10. A method of measuring radiation by illuminating a stimulate phosphor as a radiation detecting medium with exciting light to read the dose of radiation accumulated in the stimulate phosphor, wherein a laterally radiating optical fiber is used as a radiator of the exciting light.

11. The method according to claim 10, wherein the radiator of exciting light is a semi-laterally radiating optical fiber that radiates light from a portion of its circumference.

12. The method according to claim 11, wherein a light reflector is provided on the side of the semi-laterally radiating optical fiber which is remote from the light radiating part of the fiber or around its entire circumference except the light radiating part.

13. A method of measuring radiation with a radiation detecting portion comprising in superposition at least one laterally radiating optical fiber, a stimuable phosphor as a radiation detecting medium, an optical bandpass filter centered at the wavelength of fluorescence, and at least

one wavelength shifting optical fiber sensitive to the wavelength of stimulated fluorescence.

14. An apparatus for measuring radiation by the method according to claim 13 using a radiation detecting portion which comprises in planar superposition at least one laterally radiating optical fiber, a stimuable phosphor as a radiation detecting medium, an optical bandpass filter centered at the wavelength of fluorescence, and at least one wavelength shifting optical fiber sensitive to the wavelength of stimulated fluorescence.

15. The apparatus according to claim 14, wherein the radiation detecting portion has at least one laterally radiating optical fiber that is sandwiched between two units each comprising in planar superposition a stimuable phosphor as a radiation detecting medium, an optical bandpass filter centered at the wavelength of fluorescence, and at least one wavelength shifting optical fiber sensitive to the wavelength of stimulated fluorescence.

16. An apparatus for measuring radiation by the method according to claim 13 using a radiation detecting portion which has at least one laterally radiating optical fiber that is sandwiched between two stimuable phosphors in planar superposition that are different in the performance of radiation detection.

17. An apparatus for measuring radiation by the method according to claim 13 using a radiation detecting portion which comprises in cylindrical superposition at least one laterally radiating optical fiber positioned in the center

that is surround by a stimuable phosphor as a radiation detecting medium, an optical bandpass filter centered at the wavelength of fluorescence, and at least one wavelength shifting optical fiber sensitive to the wavelengths of stimulated fluorescence and prompt fluorescence that is used to detect both types of fluorescence.

18. An apparatus using at least two units of the radiation detecting portion according to any one of claims 13 - 17, wherein at least one optical fiber capable of radiating light from the lateral sides of the respective units and at least one wavelength shifting optical fiber sensitive to the wavelengths of stimulated fluorescence emitted from the respective stimuable phosphors are connected by an optical fiber.

19. The apparatus according to claim 18, wherein an optical delay mechanism is provided between optical fibers for connecting at least one optical fiber capable of radiating light from the lateral sides of the respective units.

20. An apparatus for measuring radiation with the radiation detecting portion according to any one of claims 13 - 19 that is provided over a long distance along the site of measurement, wherein pulsed exciting light having a time duration not longer than the lifetime of fluorescence from the stimuable phosphor is launched into at least one laterally radiating optical fiber, the stimulated fluorescence from the stimuable phosphor is detected with a photodetector via the wavelength shifting

optical fiber, and the positional distribution of the dose of radiation incident at the site of measurement is determined from the relationship between the time of incidence of pulsed exciting light input from the light source into at least one laterally radiating optical fiber and the temporal distribution of the intensity of the stimulated fluorescence detected by the photodetector.

21. The apparatus according to claim 20, wherein a streak camera is used as the photodetector of stimulated fluorescence output from the wavelength shifting optical fiber, the temporal distribution of the intensity of stimulated fluorescence is measured synchronously with the pulsed exciting light, and the positional distribution of the dose of radiation incident at the site of measurement is determined from the relationship between the time of incidence of pulsed exciting light inputted from the light source into at least one laterally radiating optical fiber and the temporal distribution of the intensity of the stimulated fluorescence detected by the photodetector.

22. The apparatus according to any one of claims 18 - 21, wherein the process comprising the steps of illuminating the stimuable phosphor with pulsed exciting light having a time duration not longer than the lifetime of fluorescence from the stimuable phosphor via at least one laterally radiating optical fiber and detecting the emission of stimulated fluorescence from the stimuable phosphor via the wavelength shifting optical fiber is repeated more than once, the temporal distribution of the intensity of

stimulated fluorescence is integrated and on the basis of the result of integration, the positional distribution of the dose of radiation incident at the site of measurement is determined from the relationship between the time of incidence of pulsed exciting light input from the light source into at least one laterally radiating optical fiber and the temporal distribution of the intensity of the stimulated fluorescence detected by the photodetector.

23. An apparatus for measuring radiation using a radiation detecting portion comprising in superposition at least two stimuable phosphors as a radiation detecting medium, an optical fiber for illuminating each stimuable phosphor with exciting light, an optical bandpass filter centered at the wavelength of the stimulated fluorescence emitted from the respective stimuable phosphors upon illumination with exciting light, and at least one wavelength shifting optical fiber that is sensitive to the wavelength of fluorescence from the respective bandpass filters and which is used to detect the emission of the stimulated fluorescence.

24. In an apparatus for reading radiation image from a stimuable phosphor sheet which comprises a stimuable phosphor sheet, an exciting light source generating light of a wavelength that can excite the stimuable phosphor, a mechanism for illuminating the stimuable phosphor sheet with a rectangular pattern of the output exciting light, an optical bandpass filter centered at the wavelength of stimulated fluorescence, a wavelength shifter bundle

comprising a ribbon array of wavelength shifting optical fibers that can be excited with the stimulated fluorescence, an optical bandpass filter centered at the wavelength of the shifted fluorescence, a photodetector capable of multi-channel detection of the fluorescence emitted from the respective wavelength shifting optical fibers, and a signal processing unit that processes the signals from the multi-channel detector to produce digital signals for constructing a radiation image, the improvement wherein in order to illuminate the stimuable phosphor sheet with a rectangular pattern of the exciting light from the light source, laterally radiating optical fibers are arranged on the surface of the stimuable phosphor sheet in a direction perpendicular to the bundle of wavelength shifting optical fibers, the exciting light is launched from the light source into the laterally radiating optical fibers in turn, and the dose of radiation accumulated in the stimuable phosphor sheet is read together with the associated position information.

25. An apparatus for performing the radiation measurement according to any one of claims 13 - 17, wherein the stimulated fluorescence that is output from both ends of the wavelength shifting optical fiber as wavelength shifted fluorescence is passed through an optical bandpass filter centered at the wavelength of said fluorescence and detected with the same photodetector.

26. An apparatus for performing the radiation measurement according to any one of claims 10 - 25 which uses the

stimulable phosphor according to any one of claims 3, 4 and 5.

27. A method of performing the radiation measurement according to any one of claims 3 - 6, 10 - 19 and 24 - 26, wherein the dose of radiation accumulated in the stimulable phosphor according to any one of claims 7, 8 and 9 is measured.

28. An apparatus for performing the radiation measurement according to any one of claims 1 - 27, which is capable of detecting neutrons using a neutron detecting medium which is a stimulable phosphor that incorporates, mixes or combines with at least one neutron converter selected from among Gd,  $^6\text{Li}$  and  $^{10}\text{B}$  that is capable of converting neutrons to an ionizable radiation.

29. The apparatus according to claim 28, wherein a neutron detecting portion using a radiation detecting medium capable of detecting neutrons is combined with a fast neutron moderator to enable detection of fast neutrons.

30. An apparatus for performing the radiation measurement according to any one of claims 1 - 29, wherein the temperature of the stimulable phosphor as a radiation detecting medium is measured with a temperature sensor and the dose of accumulated radiation that is measured by illumination with exciting light is corrected on the basis of the measured temperature.